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ABSTRACT

The transition from secondary to postsecondary science courses is characterized by low student retention rates. Student difficulties may be related to an incongruity between secondary student preparation and postsecondary faculty requirements. The purpose of this study was to learn how well matched secondary and postsecondary teacher assumptions were about the student characteristics required for success in introductory college biology courses. Faulty participants were interviewed and engaged in homogeneous and heterogeneous focus groups. Interviews and focus groups included three secondary and four postsecondary faculty members. They developed tables of specifications for student requirements and responded to surveys. Results indicate that secondary and postsecondary faculty have differing assumptions about the importance of certain student characteristics. The study further shows that communication improves the agreement of the two groups about such assumptions. The results point to future research possibilities and make it possible to draw educational implications for retention. Four appendixes provide supplemental information and contain the interview protocols. (Contains 3 figures and 22 references.) (SLD)

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Faculty Assumptions about the Student Characteristics Required for Success in Introductory College Biology

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1

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Abstract

The transition from secondary to post-secondary science courses is characterized by low student retention rates. Student difficulties may be related to an incongruity between secondary student preparation and post-secondary faculty requirements. The purpose of this study was to learn how well matched secondary and post-secondary teacher assumptions were about the student characteristics required for success in introductory college biology courses. Faculty participants were interviewed, engaged in homogeneous and heterogeneous focus groups, developed tables of specifications for student requirements, and responded to surveys. The results of this study indicate that secondary and post-secondary faculty have differing assumptions about the importance of certain student characteristics. The study further showed that communication improved the agreement on those assumptions between the two groups. The results point to future research possibilities and educational implications for retention are drawn.

Introduction

A Cultural Transition

It is during the first-year college experience that students are incorporated into a culture of learning qualitatively different from their secondary schools' (Upcraft and Gardner, 1989; Tinto, 1993). The cultural change from secondary to post-secondary education causes social and academic student difficulties (e.g., Tinto, 1993; Razali and Yager, 1994; Seymour and Hewitt, 1997). The transition to college is characterized by academic problems for first-year students that contribute to deleterious effects on undergraduate first-year student retention rates (Tinto, 1993).

The Leaky Pipeline

Particularly, the academic difficulties students face in the sciences are a national concern. The National Research Council (1996) points out a twenty-five year decline in freshman interest in choosing majors in undergraduate science, with potential majors particularly dissatisfied during the transition from high school to college science programs (Seymour and Hewitt, 1997). Only half of high school seniors declaring a major in science remain majors at the end of the first year of college. A similar retention rate of about 50% also exists for majors in the biological sciences during this period (National Research Council, 1990).

During college, the highest risk of student loss for science majors occurs at the end of the freshman year (Seymour and Hewitt, 1997). Interestingly, very few students transfer into science majors after college enrollment and there is always a net loss (Hilton and Lee, 1988). Green (1989) thus points out that "not only do the sciences have the highest defection rates of any undergraduate major, they also have the lowest rates of recruitment than any other major" (p.478).

Difficulty in improving retention rates, particularly among first-year college biology (life science) majors, may produce a variety of harmful effects on the society. For example, leaks in the science student pipeline are linked to declines in scientific literacy for adults (National Research Council, 1996). Such declines contribute to reduced numbers of qualified individuals available for life science teaching, research development, and technological advancement.

Introductory Courses

It is the introductory science courses that have the poorest student retention rates in undergraduate sciences. At the same time, introductory courses offer the first opportunity for students to transition

to the academic demands of college science (Mitchell, 1990). Therefore, students must enter introductory courses with the prerequisite knowledge, skills, and dispositions to enable them to successfully engage in the required activities of the course.

Post-secondary teachers design their introductory courses with certain assumptions about the characteristics of their incoming students (Mitchell, 1990). Current research also documents that secondary school science teachers base their instructional and curricular goals on requirements of college instructors of freshmen students (Yager, Snider, and Krajcik, 1988; Mitchell, 1990). The needs of K-12 science education are, therefore, inherently linked to undergraduate education. Thus, "a sound curricula in the college years cannot be developed unless students are given a solid elementary and secondary science background on which to build" (National Research Council, 1996, p. 35).

Instructional design in the introductory college courses should, therefore, be aimed at successfully engaging students in course goals that are appropriate given their secondary preparation. This requires that incoming student characteristics are suitable for the requirements post-secondary faculty have set for the introductory courses. The clear and effective matching of faculty requirements with incoming student characteristics is strongly related to undergraduate student success (California Higher Educational System, 1984). Although a variety of instructional factors have been cited in the literature that contribute to a low retention rates among biology majors, an obvious determinant for student success is the degree of match between introductory course expectations with incoming student abilities.

It is important to study the characteristics of introductory life science courses to determine the instructional and curricular factors contributing to the retention of students. Often, "there are many myths about what colleges expect" and about "what experiences in high school make a difference in college" (Yager, 1986, p. 24). Improved communication between secondary and post-secondary faculty would necessarily precede a smoothening of student transitions from high school to college life sciences. However, related research shows few empirical studies exploring communication between secondary and post-secondary biology faculty and their assumptions about the preparation needed for success before entering college biology.

Do Faculty Assumptions Matter for the Transition to College?

Differences may exist between what post-secondary faculty assume about their incoming students' characteristics and what the

secondary preparation actually produces in terms of student characteristics. If this is the case, then post-secondary teachers may not be able to design their courses with any real certainty about first-year student academic characteristics. One possible contribution to the current poor retention rates among first-year college biology majors may result from an inability of instructors to determine the appropriate learning goals for their incoming students (Seymour and Hewitt, 1994; Barrowman, 1996). If post-secondary teacher requirements do not match what they assume entering students actually know and are able to do, there would be an inherent obstacle to success.

This study shows that there is a difference in the assumptions that secondary and post-secondary teachers have about the academic student characteristics required for success in introductory college biology. Consequently, the reported declines in undergraduate recruitment and retention in science are linked to discontinuities in faculty requirements at the secondary/post-secondary interface (Tinto, 1993). This difference may result in a lack of agreement on what constitutes good preparation for college. The disparity in preparation is a reason for the academic culture shock students experience during their transition from secondary to post-secondary education (Tinto,1993; Chaskes,1996).

Although serious deficiencies in biology education have been recognized by the scientific community, few research studies have addressed the importance of defining faculty assumptions about the student characteristics required for success in post-secondary life science courses (Barrowman, 1996). No reported research has gone beyond surveying faculty goals to explore the realities of faculty requirements in introductory courses. The purpose of this study was, thus, to document high school biology teachers' assumptions about the knowledge, abilities, and dispositions required for success in introductory biology courses and the degree to which their assumptions match those of faculty who teach introductory college biology courses.

The Research Questions

This research study measured the congruence of secondary and post-secondary faculty assumptions about the student characteristics required for success for entering first-year college biology students. Specifically, the study sought to answer the following questions:

1. What are secondary biology teachers' assumptions about the knowledge, abilities, and dispositions required for success in introductory college biology (life science) courses?

2. What are the post-secondary biology teachers' assumptions about the knowledge, abilities, and dispositions required for success in introductory college biology (life science) courses?
3. Do secondary biology teachers' assumptions about the knowledge, abilities, and dispositions required for success in introductory college biology (life science) courses match with those of post-secondary biology teachers'?

Methodology

Overview

This study utilized an ethnography-based methodology that employed open-ended questioning in interviewing participants based on Glesne and Peshkin (1992) and Seidman (1998), focus group interactions according to recommendations by Edmunds (1999), and a data analysis procedure based on Strauss and Corbin (1998). First, faculty were interviewed individually and the results of the interviews summarized. Then all faculty participants met in focus groups to discuss the summary data.

Participant Selection and Setting

Participants were identified and recruited based on their willingness and availability to take part in the study. These convenience samples consisted of life science faculty who instructed introductory biology from two high schools, a two-year college, and a four-year college in the Northeast. The interviews and focus groups included a total of seven participants (three secondary and four post-secondary members) from a particular sequence of schools (local Northeastern High Schools→a local Northeastern two-year college→a local Northeastern four-year college). The sequence of educational institutions is termed a feeder unit, which instructs a population of students locally through successive stages of secondary and post-secondary curriculum.

Interviews

The techniques of open-ended questioning were used during the interviews (Glesne and Peshkin, 1992; Seidman, 1998). Six questions were asked of the participants to facilitate a discussion of faculty requirements in relation to first-year college student abilities and retention in introductory courses during a 45 minute period. Because a main objective of this study was to identify what student characteristics are perceived as important for introductory college biology courses, a researcher-developed set of interview questions was prepared for the

interview of life science faculty. The same set of questions was used for secondary, two-year, and four-year college participants. The questions are given in the Appendix C.

Focus Groups

The same interviewed participants were then asked to participate in group interviews focusing on their assumptions about the student characteristics required for success in first-year college biology. This interaction has been termed a focus group and is described by McMillan (1992) as "...most useful for encouraging subjects, through their interaction with one another, to offer insights and ideas about a concept, idea, value...about which they are knowledgeable" (p. 221). The focus group interactions followed the recommendations by Edmunds (1999) for focus group procedures. A list of prompt questions for focus group meetings was an outcome of the interviews and was included in the discussion guide for the focus group. The focus groups were conducted using the prompt questions to facilitate the discussion. The specific focus group protocol used in this study is given in Appendix D.

Three focus groups were conducted. One whose participants were secondary faculty, a second whose participants were only post-secondary faculty (homogeneous groups), and the third whose participants were secondary and post-secondary faculty (heterogeneous focus group). The first homogeneous focus group included only secondary life science faculty members (three members), the second homogeneous focus group included only post-secondary life science faculty members (two two-year college biology faculty and two four-year college faculty). The third focus group (heterogenous) included all seven members from the homogeneous focus groups (three secondary faculty and four post-secondary faculty). The focus group interactions each lasted about ninety minutes. A survey of student characterictics was produced from the interviews and used as a survey instrument with the participants at the beginning and end of the heterogeneous focus group.

Data Analysis

The analysis of interview and focus group transcripts used a coding system to classify and categorize the data as recommended by Strauss and Corbin (1998). A coding system is defined as the formal classifying and categorizing of data to produce form and possible meaning (Glesne and Peshkin, 1992). The data analysis required conceptualizing defined categories (or codes) for the data, and refining those categories in terms of their properties (characteristics of the categories) and dimensions (the intensity of that characteristic along a continuum) to build theory.

"Events, happenings, objects, and actions/interactions that are found to be...similar or related in meaning are grouped under...categories" (Strauss and Corbin, 1998, p.102) and in this study, faculty assumptions about student characteristics comprised the central codes.

A code book method organized the codes so that each data piece received a code name and number to identify a central idea or concept. The code book was used to identify and categorize relevant data. A reexamination of the codes and data were performed after each stage of the study to determine the range of potential meaning of the data, as suggested by Strauss and Corbin (1998).

As a final step in the analysis, a simple frequency count of the coded themes was taken to identify the relevant trends. A visual representation of the participants' responses was also developed using a matrix. This aided in the triangulation of the findings of the interviews, focus groups, and tables of specifications (Glesne and Peshkin, 1992).

Match of Research Questions and Methodology

The focus of this ethnographic approach was on collaboration and participant communication, a main benefit of matching this methodology with the research questions. Because the related literature attributes the mismatch of student science preparation between high school and college to a lack of communication among faculty, this kind of ethnographic methodology sought to ameliorate the problem at the local level. The methodology fostered communication among participant faculty members acting as a first step in bridging the gap between secondary and post-secondary life sciences. This study sought to improve such communications through face-to-face interactions in focus groups and by involving each participant in the study as it proceeded (for example, in preparing for the focus groups, determining a student characteristics survey, and making recommendations in the follow-up communication).

Results

Results of this study are divided into four sections: 1) The frequency with which secondary and post-secondary faculty mentioned student characteristics; 2) Faculty rankings of student characteristics; 3) Participant-developed student characteristics survey; and 4) Themes emerging from the research.

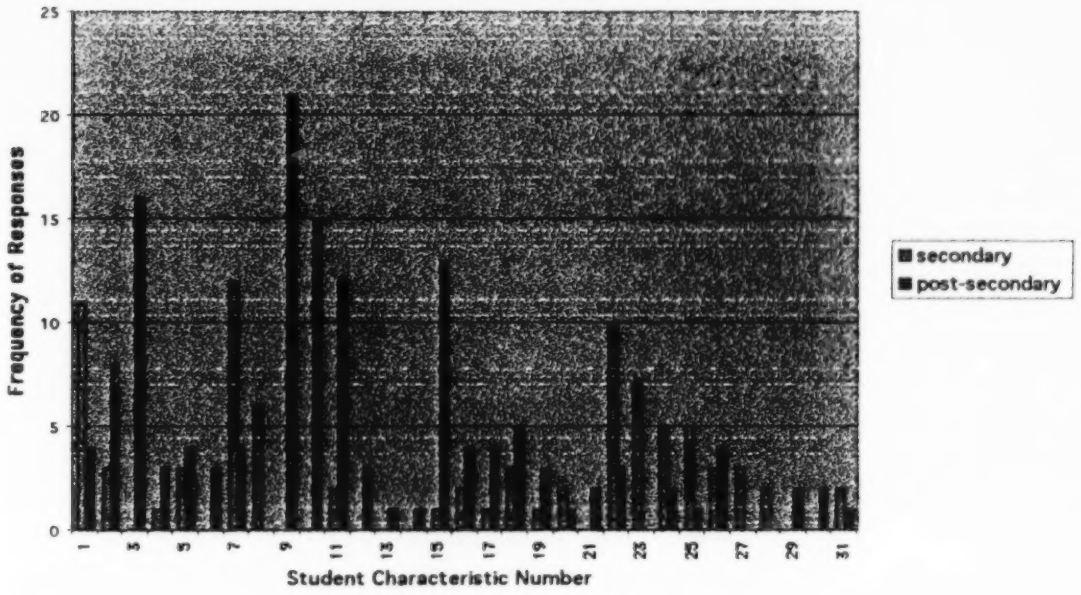
1) Frequency of Faculty Responses

The frequency with which secondary and post-secondary faculty mentioned their assumptions about the student characteristics important for success in introductory college biology is depicted in Figure 1. The frequency data suggest that secondary faculty valued more highly: reading comprehension, understanding of biological vocabulary, interpersonal communication, self-discipline, and Latin as requirements for incoming introductory college biology students than did post-secondary faculty. Conversely, the data show that post-secondary faculty valued more highly: writing ability, integrating biology with other courses, mathematics skills, and an ability to ask questions.

2) Faculty Rankings of Characteristics

Participants individually ranked a list of student characteristics, in order of importance, for students entering introductory college biology. Participants ranked the list twice. The first ranking exercise, after the homogeneous focus group meetings, and the second ranking exercise after the heterogeneous focus group. The secondary faculty group ranked higher (by over five points compared with the post-secondary group) these characteristics: perseverance, self-confidence/self-esteem, time management, independence in studying, and delay of gratification of results as compared with the post-secondary faculty. The post-secondary faculty group ranked higher (by over five points as compared with the

Figure 1: Frequency of Interview Mention



Note. Student Characteristic Number: 1.Definitions of biology terms; 2.Knowledge of biology concepts; 3.Integration of biology within subject and across curriculum; 4.Applying biology to real life; 5.Basic Hands-on lab knowledge and abilities; 6.Chemistry knowledge; 7.Reading Comprehension in science; 8.Knowledge of Latin; 9.Writing Skills; 10.Math to decimals/fractions; 11.Math to algebra; 12.Math to statistics; 13.Math to calculus; 14.Physics knowledge; 15.Asking questions; 16.Studying in groups; 17.Explaining biology to others; 18.Organization of information; 19.Separating Information; 20.Notetaking; 21.Time management; 22.Communication; 23.Self-discipline; 24.Perseverance; 25. Self-Confidence/Self Esteem; 26.Enthusiasm; 27.Independence; 28.Delay of gratification for results; 29.Critical Thinking; 30.Problem solving; 31.Computer skills.

secondary group) these characteristics: basic mathematics, algebra, writing, chemistry knowledge, physics, and problem solving.

The relationship of secondary and post-secondary group mean rankings of characteristics for the first exercise is shown in Figure 2. A regression analysis comparing secondary and post-secondary group rankings reveals an r-squared value = 0.1501. This indicated that during the homogeneous focus group experience, faculty shared a 15% relatedness overall in their ranked assumptions about the importance of

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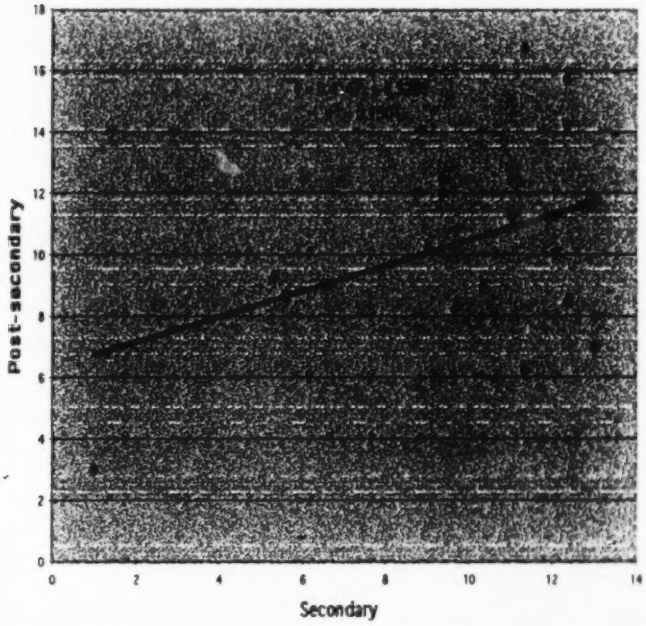
characteristics for students entering introductory college biology.

Figure 2: Relationship of Secondary/Post-secondary Homogeneous Focus Group Rankings



A regression analysis comparing the secondary and post-secondary group rankings for the second exercise reveals an r-squared value = 0.3429. This value indicates a relatedness of 34% in the scores between the two groups. Comparing pre- and post-heterogeneous focus group scores shows an increase in relatedness of rankings by 19%.

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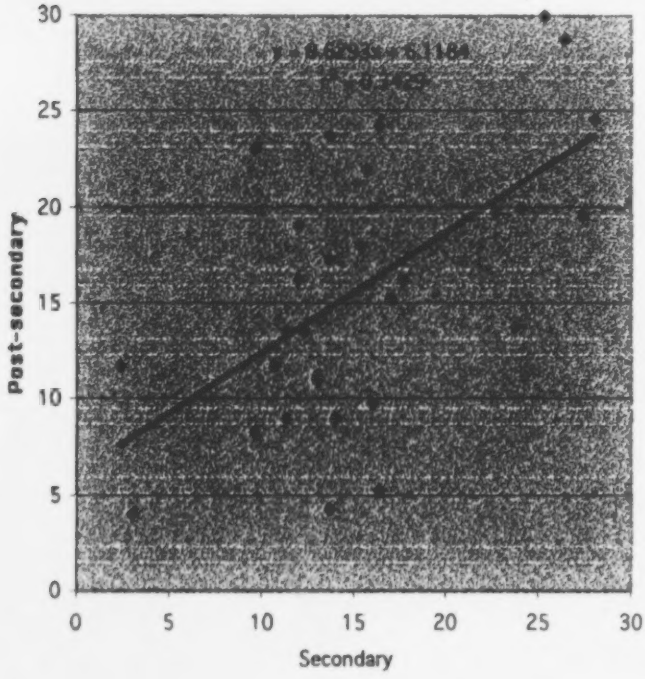
Figure 3: Relationship of Secondary/Post-Secondary Assumptions in Post-Focus Group Rankings



3) Student Characteristics Survey

A product of the heterogeneous focus group interaction was the cooperative development of a survey for student characteristics important for success in introductory college biology. The survey is a list of characteristics that comprise each of the student characteristics agreed on by the secondary and post-secondary participants to be important knowledge, abilities, and dispositions for students entering introductory college biology. The survey is shown in the Appendix, in no order of importance, and includes the student characteristic followed by the specifications enumerating the parts that comprise each characteristic.

4). Themes Emerging From The Research

Although the faculty collectively produced a table of specifications for their assumptions about the student knowledge, abilities, and dispositions important when entering introductory college biology, there was disagreement as to the extent of the importance of many student characteristics. All participants were interviewed individually, worked in one homogeneous and one heterogeneous focus group, and engaged in follow-up communication with the researcher after the completion of the

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study. An ethnographic description of the themes emerging from the study is contained within this section.

Isolation of the Secondary Faculty

During the study, secondary participants consistently expressed uncertainty about what post-secondary participants expect of the students they are preparing for introductory college biology. To illustrate, when asked by the researcher about what academic knowledge and/or abilities were important for students to have when entering introductory college biology, one respondent first answered, "I don't know since I'm not a college teacher..." and another expressed that he was "... so far away from [college biology]. When I graduated it was years ago. I am not up with technical aspects of today." When asked about study skills requirements for introductory college biology, the secondary participant who taught an AP Biology course first answered, "I wish I knew." This isolation was demonstrated as secondary participants placed high importance on characteristics that post-secondary participants considered outdated, namely Latin knowledge and note-taking skills.

Secondary Faculty Emphasis on Latin Knowledge

During the interview process, all secondary participants mentioned the importance of Latin knowledge as an academic characteristic for students to have experienced to be successful in introductory college biology. Its importance was based on nomenclature and vocabulary learning, with comments offered by secondary participants such as, "words are thrown at you in college, and with Latin you can probably figure out where they are coming from" and " it can be useful for scientific names." Another recognized that the prerequisite may have changed in stating, "I found it disappointing when colleges stopped requiring it for biology majors," but continued to express its importance for contemporary students.

When the post-secondary faculty confronted secondary members with comments such as "I don't think it has any value" and "not important", the secondary group offered little of their previous position except for a dismissed comment, "It shouldn't be a requirement but it's very beneficial."

Note-taking Study Skills

Secondary faculty also emphasized note-taking as an important student characteristic both during the interview process and in their rankings. This prerequisite was drawn from their memory of their experiences in college classes as students. However, during the heterogeneous focus group, the importance of this characteristic was

contested by a post-secondary member. The following post-secondary participant comment illustrated the change in requirements for note-taking in contemporary introductory college biology courses,

> Well a number of my colleagues have taken into the practice of providing the students with good flushed out outlines of the lectures so they're not looking at the top of the students' heads while they lecture. Instead they're making good eye contact and trying to draw the students into the discussion.

When a secondary participant retorted that "if you take good notes then you can formulate how you need to remember it", another post-secondary member ended the discussion with, "Its not an important skill." This clear difference in group positions on note-taking was illustrated in the quantitative ranking results as well. No agreement was reached by the end of the process.

Disagreement on Biology Content

The secondary faculty stressed biology vocabulary knowledge as an important characteristic during the interview and focus group interactions, but the post-secondary faculty showed a low frequency of mention for this characteristic during the same interactions (see Table 1, Figure 1). In numerous statements, every secondary faculty participant described good preparation for college biology as the successful learning of a common vocabulary. A difference in emphasis on vocabulary between secondary and post-secondary faculty was most clearly demonstrated during the heterogeneous focus group interaction, during which a secondary and post-secondary faculty member disagreed on the importance of biology vocabulary knowledge. The secondary participant stated that "sometimes a communication of ideas is pretty difficult without a vocabulary." Another secondary group member added that "there should be an underlying assumed body of knowledge if [the student] passed the Regents...". To this a post-secondary participant stated that "the terminology can be learned [in introductory college biology], it changes, uh, new terms come up as technology and knowledge advances. I'm less hung up on the student's understanding of a strong vocabulary as I am on the second issue, the concepts." The third secondary faculty member then retorted that "vocab is vocab... concept or not, I would like a kid going to college biology to have a clue about what photosynthesis is..." The post-secondary member disagreed stating, "I don't find a lack of understanding of biology vocabulary to be

an impediment to success in my course...whether they can understand the word roots or the vocabulary itself... I don't see it as a major issue in my teaching." Another post-secondary member defended this stand, expecting students to enter introductory college biology with " the skills so they can utilize resources so they can learn those kinds of terminologies."

During the homogeneous post-secondary faculty exercise, participants spent little time emphasizing vocabulary as an important student characteristic. While one gave weak support for it stating that "a little bit of fundamental knowledge of basic prefixes, suffixes, and roots could contribute to their success" another immediately countered with "sometimes a little knowledge is a bad thing. Kids are resistant to tackle new terminology, new vocabulary if they think they already know it." Thus, both in groups and alone, post-secondary faculty differed from secondary participants in their emphasis on knowledge of vocabulary and word parts for introductory college biology.

Post-Secondary De-emphasis on Biology Concepts

During the interview process, each post-secondary faculty member made comments that de-emphasized conceptual biology knowledge as an important pre-requisite to success in introductory college biology. One participant's statement, "I don't care what biology you know" reflected this sentiment. Another participant said, "It's not knowledge but more skills that I'm concerned with...that students should have in mathematics ---plotting, interpolation, algebra—and writing skills--the ability to communicate properly on exams." Another stated that "In most cases [the students] lack the skills even though they have good backgrounds" and another argued that there should be "less emphasis on knowing biology when they come in and more on math and writing skills." Conversely, secondary participants emphasized conceptual knowledge in biology as an important requirement.

Integration Across the Curriculum

The ability of students to integrate biological knowledge with other content areas was another characteristic emphasized by post-secondary but not secondary participants during the interview process. One post-secondary faculty member stated that the introductory college biology course "expects them not to just learn some terms but putting it into context... try to carry it in other areas." Another mentioned this during the interview and stated, "If you can relate the information with other subjects, I think it facilitates the learning process..." and that a good lab "forces the student to use a variety of resources to synthesize

information and analyze this...[so that] they see the solution to one problem generates other questions. Without this ability it'll be hard for [students] to do well in the course." A concurrent theme of emphasizing integration across the curriculum and blaming secondary faculty during the interviews was coupled with retention issues. One participant stated that students "... who do poorly compartmentalize information, where they can't recognize it and apply it to another course."

Post-Secondary Emphasis on Writing

Writing ability was ranked and rated highest and was in the highest frequency of mention for post-secondary faculty as an important characteristic for students entering introductory college biology. During the interview and homogeneous focus group process, writing was not mentioned at all by secondary faculty.

All post-secondary participants posited numerous comments concerning this emphasis. One faculty member stated that "...we find that there is generally a lack of ability or knowledge for writing a scientific paper. They're not adequately trained in APA or MLA style. Not trained in doing citations." Another drew a link to writing and success in introductory college biology stating that "there is a disparity in those that can write and express themselves and those that can't and don't succeed" and in terms of their assessment "students may know the concepts but can't put it into words on the short answers on the exam."

Secondary Faculty Confusion on Mathematics Requirements

During the interviews, secondary participants offered contradictory statements regarding the importance of mathematics as a prerequisite knowledge or ability for introductory college biology. During most of the discourse on mathematics in the focus groups, the secondary faculty did not participate and all three secondary participants expressed surprise to hear that knowledge and abilities in algebra and statistics would be important student characteristics when entering introductory college biology.

Most Important Student Characteristic Category

When asked, at the end of each interview, which of the characteristic categories would be classified as holding the most important value for student success in introductory college biology, all three secondary participants answered personal characteristics. Post-secondary faculty split between non-biology content and study skills.

Secondary Faculty Emphasis on Personal Characteristics

Throughout the interview process, secondary faculty emphasized personal characteristics for students that would contribute to successful

completion of introductory college biology. One participant emphasized self-discipline with comments such as, "... it's the discipline, the self-esteem, the belief in one's self... the belief that there is not always an easy out and some things have to be learned the hard way." Another offered that "a good student has enthusiasm, a positive outlook on life" and should be "smiling, bright, talking. The college teacher looks for this." Another participant claimed that in college biology students must have "a self starting attitude, making the choices to study independently" and "having the self-confidence to go into the lab, look up some terms on their own... to do a lab on their own." Considering that post-secondary faculty mentioned these characteristics very infrequently, a difference in emphasis is demonstrated.

Epistemological Differences Between Faculty Groups

Participant groups appeared to differ in their view of knowledge and knowledge construction. During their interviews, secondary faculty viewed as important a student understanding that, " there are right and wrong answers to questions..." and "that there are some things you need to look up in a book—learning to do that." Another elaborated that "you can be successful without being analytical" in introductory college biology. These statements are consistent with an epistemological view of learning that is conclusion-based and according to the King and Kitchener (1994) hierarchy of knowledge, based on authority. The secondary group also demonstrated this perspective during the heterogeneous focus group, so that when asked about the mechanism of how critical thinking and analytic skills contributes to success, one commented that "those skills build as students get more and more immersed in what they're reading...they learn more vocabulary."

In contrast to the views held by secondary participants, post-secondary faculty consistently demonstrated, during interviews and focus group meetings, an evaluation-oriented view of knowledge and knowledge construction. Numerous comments showing that they expect students to "... critically think to realize that solutions are not always black and white" show an epistemological level of uncertainty consistent with the hierarchy offered by King and Kitchener (1994). When discussing the importance of being able to ask questions, a characteristic emphasized by post-secondary faculty, an emphasis on open-ended questions was prevalent. One participant stated during the heterogeneous focus group that "the best question a student can ask me is why."

A post-secondary de-emphasis on facts and factual knowledge was demonstrated with one post-secondary participant commenting that he

expected students to consider that "... an understanding of science is not just facts, but a process of understanding uncertainty; frustration." The certainty of facts and vocabulary knowledge emphasized by secondary faculty juxtaposed the uncertainty of knowledge expressed by post-secondary faculty. To illustrate, a post-secondary faculty member commented that students should be able to view results with "... a general knowledge that there's uncertainty."

Discussion

Process Contribution to Bridging Gap

This study heightened the awareness of participants about the congruence of their assumptions with other faculty groups. The methodology chosen was uniquely effective in impelling faculty to first come to consensus on the importance of certain student characteristics within their cohort groups and then to confront their viewpoints with another group. It thereby required secondary and post-secondary participants to develop group positions and relationships and then to defend their assumptions in a possibly disagreeable environment. Simple communication among faculty might have been less effective in uncovering the degree to which the secondary and post-secondary group assumptions matched. When faculty were first contacted, the secondary group believed their teachings were effective in preparing students for college biology and the post-secondary group deemed their instruction appropriate for the knowledge, abilities, and dispositions of their incoming students. During the study, however, both groups were compelled to alter this complacency, after confronted with alternative data about the state of the academic transition students face between secondary and post-secondary biology.

The study thus showed that communication between secondary and post-secondary groups had favorable results on improving the overall congruence of participant assumptions about the knowledge, abilities, and dispositions required for student success in introductory college biology. As evidence, the regression analysis of rankings by faculty before and after the heterogeneous interaction indicated an improved relatedness between group assumptions of over 19% (from an r-squared = 0.1501 to 0.3429). Heterogeneous focus group interaction also involved faculty groups defining terms (e.g., self-esteem/self-confidence), clarifying the state of differences in curricular requirements (e.g., secondary vs. post-secondary chemistry expectations), clarifying misunderstandings about

student characteristics (e.g., duplication of efforts in laboratory exercises), and coming closer to agreement for certain assumptions about student characteristics required for success (e.g. need for reading comprehension). Thus, as would be expected, an improved congruence in assumptions was achieved through the process of bringing secondary and post-secondary faculty together. It is, however, naïve to presume that a ninety-minute focus group is sufficient for ameliorating the disparity that exists between viewpoints of the two groups.

Secondary Participant Isolation

Secondary faculty emphasized specific student characteristics that were unacceptable to the post-secondary group, such as Latin knowledge, reading comprehension, and note-taking. This disagreement would be expected given the limited exposure secondary faculty have to introductory college courses (Razali and Yager, 1994) .

These prerequisite characteristics were described as outdated by post-secondary participant statements during the heterogeneous focus group. Secondary participants communicated a feeling that is best described as an isolation in the time-dimension from contemporary introductory college courses. Thus, it would be expected that a secondary reliance on old curriculum and instructional techniques for introductory college biology would be the reserve from which these faculty would draw their ideas about preparing students for college. Such limited exposure may be a result of limited communication with either post-secondary faculty or established standards. In addition, with the lack of clearly defined national and state-level guidelines for post-secondary life science course requirements and pre-requisites, a vacuum is left in secondary faculty links to the college biology courses for which they are supposed to be preparing their students (Daempfle, 2000).

The vacillation and disagreement over mathematics requirements further illustrated both the isolation secondary faculty have from post-secondary life sciences and the frustration that the process of updating their preparation of students caused the secondary participants. While basic mathematics and algebra were top ranked and most frequently discussed characteristics by post-secondary faculty, high school teachers were confused about the degree to which mathematics mattered for success in introductory college biology. It may be that secondary faculty did not realize that biology had become more mathematical since their coursework ended-particularly statistical-with the addition of new methods of research (e.g., ecological modeling, molecular biology, genetic engineering).

Incongruence of State Standards with Post-Secondary Assumptions

This disagreement on the kinds of emphases secondary participants placed on content knowledge may be a result of the secondary biology curriculum being so heavily concentrated on content and vocabulary knowledge, as established by the New York State Biology Content Standards. Stringency in secondary level instructional freedom may have contributed to the frustration the secondary participants displayed during the process. While post-secondary faculty have greater academic freedom to contend with the increased volume of content in contemporary biology, secondary faculty do not have that luxury. This constant-volume problem of content, discussed by Willeford and Clapp (1961), appears to have been dealt with by the college participant assumptions through their emphasizing skill development to enable students to acquire content independently. The SUNY 2000 (1992) standards and California Higher Education Standards (1984) for post-secondary life science courses also advocated for the critical thinking development instead of content emphases. However, secondary faculty curriculum may not be as flexible, which would help explain the disagreement secondary faculty expressed for accepting the post-secondary participant recommendations.

Links to Chemistry Expectations Research

Results of this study support work done on chemistry faculty expectations (e.g., Ogden, 1977; Stuart, 1977; Mitchell, 1990; Razali and Yager, 1994). Chemistry education literature revealed an incongruence in chemistry assumptions between secondary and post-secondary faculty. Razali and Yager's (1994) results on faculty assumptions in chemistry showed that while secondary respondents significantly emphasized content knowledge characteristics, undergraduate instructors favored other qualities. The secondary group in this study also focused on content, such as biology vocabulary and terminology, while post-secondary faculty again disagreed on its importance.

Similarly, post-secondary faculty, in the supporting literature and in this study, recommend that secondary teachers should increase integration of prior knowledge with other content areas (Razali and Yager, 1994). Both the results of this study and the chemistry findings showed that high school teachers who are confident that the student characteristics they assume are important in their students' preparation for college are, in fact, concentrating on something that college professors do not value highly in college science courses. However, through participation in this study, an improved congruence in rankings,

ratings, and communicated faculty assumptions between the secondary and post-secondary groups attests to the importance of communication in diminishing the disjuncture in student preparation across the secondary/post-secondary interface.

Implications for Educational Practice

This study offers a set of prerequisite student characteristics for the reader which, in conjunction with the related literature, can be used to develop curriculum that more efficiently prepares students for their transition from secondary to post-secondary life sciences. The student characteristics assumed to be important by participants can indicate secondary and post-secondary instructional emphases that are needed for helping students to reach the requirements for success in introductory college biology. To illustrate, it might be prudent for secondary biology instructors in this study to increase focusing their preparation of students in terms of writing and mathematics skills. Post-secondary faculty in this study might focus on helping students without such preparation to meet their requirements.

These kinds of changes advocated should be determined within local feeder units with their own results. Changes should be considered in terms of improvement in the curriculum at both secondary and post-secondary institutions. Based on the findings, curricular improvement could involve a different approach to text usage and assessment, the clarification of prerequisite requirements, improved instructional and curricular preparation to help pre-college biology students meet college faculty demands, and institutional action.

Communication of Requirements with Students

It is not enough that faculty requirements be defined in college biology courses. Post-secondary requirements should also be communicated effectively to students and the course assessment measures should reflect those academic demands. Barrowman (1996) claimed college faculty requirements were regularly not clearly communicated to students and that assessments often surprised first-year college students.

Improvement in Preparation

The results of the study should also help faculty to better understand the possible gaps in student preparation during the transition from secondary to post-secondary biology. Chemistry and biochemistry knowledge, note-taking abilities, and the ability to integrate biological topics within subjects and across other subjects, were examples of post-

secondary faculty requirements for which secondary students may not be prepared within the feeder unit.

Institutional Action

On an institutional level, an active research program, perhaps tracking non-persisting students in biology and exploring their reasons for leaving, would be beneficial to retention. Because a potential incongruence in student preparation between schools within a feeder unit is an institutional problem, safeguards against student loss should be implemented. These might include: remediative courses or workshops to lessen possible academic deficiencies caused by inconsistencies in preparation, counselling services to help students cope with academic adjustments during their transition to college biology, and recruitment of faculty willing to participate in research and communication that improves the congruence of student preparation.

Implications for Research

This study of a particular feeder unit involving five institutions is limited in its external generalizability to other institutions. However, the purpose of this study was to analyze a particular organizational infrastructure. It attempted to achieve an understanding of an existing relationship between secondary and post-secondary faculty assumptions about importance of certain student characteristics. While external generalizability is limited by the methodology of this study, the local social significance of the results are important in improving the student's transition within this feeder unit. The results do not purport to advise other institutions to do this or that, but attempt to increase understanding about the current state of affairs that may exist between secondary and post-secondary life sciences. It is the ultimate goal of this research that the incongruence found in faculty assumptions in this local study will increase awareness that such a dynamic can exist and should be further researched in other localities.

Conclusions

It is hoped that the results of this study, and the possible uses of its methodology to implement future research, will: 1) heighten the awareness of faculty regarding the importance of communication with faculty at other institutions; 2) increase the match between secondary and post-secondary faculty assumptions about the student characteristics required for success in introductory college biology; 3) help to create educative experiences for students that help them to reach faculty requirements and success in introductory college biology;

and 4) stimulate additional research to study secondary and post-secondary requirements, both assumed and actual.

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Appendix A: Table of Specifications for Faculty Assumptions About Student Characteristics Important for Success When Entering Introductory College Biology: As Developed by Heterogeneous Focus Group

1-Definitions of biological terms
2-Understanding of word roots/word parts
3-Understanding of Biological Concepts:
- Cellular Biology
- Genetics
- Evolution
- Diversity of Life
- Ecology
- Energy Release
- Regulation
- Biochemistry
- Organ Systems

4-Integration of Biological Knowledge with other subjects:
- microbes and biochemistry
- sociobiology
- medicine
- ecology/environmental issues
- bio-economics
- bio-politics
- Application of biological concepts to real life
- conceptually
- in lab experiences

5-Hands-on Lab Skills
- measurement
- metric system
- observation skills
- microscopy
- balances
- rulers
- graph paper
- pipettes

6-Chemistry knowledge
- knowledge of the four macromolecules
- endothermic/exothermic reactions

oxidation-reduction reactions
solutions
pH
enzymes
atomic structures
atomic structures and reactivity

7-Reading comprehension
reading comprehension in science

8-Knowledge of Latin words and word roots

9-Writing skills
exam essay writing
laboratory report writing

10-Communication with others
explain ideas in class
ask questions
sharing interest with others
group sharing of ideas

Mathematics skills

11-Decimals/Fractions
percentages

12-Algebra
X-Y system plotting
equation manipulation

13-Statistics
X-Y system plotting on distributions
Chi Squared general purposes
mean, median, mode
knowledge of use in polling
knowledge of use in showing uncertainty of results

14-Calculus

15-Physics knowledge related to living systems
laws of conservation of matter and energy
first and second laws of thermodynamics
law of gravity
light wave relationship of energy to frequency

study skills

16-Asking questions
why based questions

17-Group studying
for problem solving

18-Explanation of biological concepts to peers
19-Organizing information
    for lab report writing
    to follow conventions/procedures within the laboratory
20-Separating important from unimportant information
    in text reading
    in internet searching
21-Notetaking
22-Time management
23-Problem solving
24-Computer skills
    word processing
    email/internet navigation
    spreadsheets
    graphing
25-Discipline in classroom
    non-disruptive conversation in the classroom
26-Perseverance
    perseverance during research projects
    perseverance in building skills
27-Self-confidence/Self-esteem in general
    self-confidence/self-esteem to overcome failure or defeat
    self-confidence/self-esteem during biological research process
    self-confidence/self-esteem in defending results
28-Enthusiam
29-Delaying gratification for the results
30-Independence in studying
31-Critical thinking
    critical thinking to link an observation to an evaluation of data
    critical thinking to integrate biological knowledge within the subject

Note. Calculus was excluded by secondary and post-secondary faculty; Latin was included by secondary faculty and excluded by post-secondary faculty. Number and "-" indicates original expectation. Indentation indicates specification of each original expectation above.

Appendix B: The Summary of the Methodology

PHASE	PARTICIPANTS/ SETTING	DATA COLLECTION METHODS	DATA ANALYSIS/ PRODUCTS
Interviews	2-4 secondary faculty 2-4 two-year college faculty 2-4 four year college faculty	Interviews	Development of focus group prompts; tape recordings of interviews; data on faculty assumptions
Focus Groups	Secondary faculty two-year college faculty four-year college faculty	Focus groups→tables of specifications development/rankings	Tape recordings of focus group interactions; data on faculty assumptions
Follow-up	Secondary faculty two-year college faculty, four-year college faculty	Triangulation of results from interviews, focus groups, and tables of specifications; follow-up communications	Comparisons of ratings of secondary and post-secondary assumptions

Appendix C: Interview Questions

1. a. What academic knowledge/or qualities should students have to be successful in Introductory College Biology?

b. What academic knowledge/or qualities do students often lack which would help them to be successful in Introductory College Biology?

2. a. What study skills help students to be successful in Introductory College Biology?

b. What study skills do students often lack which would help them to be successful in Introductory College Biology?

3. a. What personal characteristics (about the individual student) help students to be successful in Introductory College Biology?

b. What personal characteristics (about the individual student) do students often lack which would help students to be successful in Introductory College Biology?

4. What other characteristics of an entering college student would help him or her to be successful in Introductory College Biology?

Appendix C: Interview Questions (continued)

5. a. What kinds of high school preparation do many of our students have which help them to be successful in Introductory College Biology?

b. What kinds of high school preparation do many of our students lack which would help them to be successful in Introductory College Biology?

6. What can the college or the instructor do to enhance student success in Introductory College Biology?

Appendix D: Specific focus Group Protocol

(10 min.) Introduction

- Greeting
- Purpose of Focus Group
- Ground Rules
  - role of moderator
  - confidentiality of comments/responses
  - recording equipment (explanation that it will be used)
  - importance of individual opinions (no right or wrong answers)
  - speak one at a time and as clearly as possible
- Icebreaker Exercises (participant names, institutions, courses taught, areas of interest).

(65 min.) Assumptions About Student Knowledge, Abilities, and Dispositions Required for Success in College Biology Courses

1. A list of prerequisite student knowledge, abilities, and dispositions assumed to be important by faculty for success in introductory college biology (as developed from the interviews) was presented to the participants. "Are there any other knowledge, abilities, and dispositions not on this list?" (asked by investigator) A tally of the

number of times each item on the list was mentioned during the interviews and was included on a visual aide in the room.

2. "Why do each of the knowledges and abilities on the list contribute to student success in introductory college biology?" ("How do you think the mechanism of knowing or having a particular prerequisite ability contributes to the success of the student in introductory college biology?"). (asked by investigator)
3. "Please give specific example(s) of these expectations and why they contribute to student success in introductory college biology?" (asked by investigator) The reasons for why each of the items link with success and the specific examples of each reason will be written on a visual aide in the room.
4. "Tell us a story or describe a particular incoming college student who has had all of the knowledge, abilities, and dispositions to succeed in your course. Did they succeed? Why or why not?" (Was asked by investigator as a facilitator of discussion).

(10 min.) <u>Ranking/Rating of Expectations</u>

"Develop a group ranking order, from most important, of the student knowledge, abilities, and dispositions you expect of incoming college biology students." (directed by investigator) (A

list of student characteristics was provided from the homogeneous focus groups on poster-boards in the room. The list of student characteristics was comprised of the characteristics agreed upon by both the secondary and post-secondary homogeneous focus groups to be important knowledge, abilities, and dispositions for students entering introductory college biology.).

Participants were asked to rank, from #1 (most important) to #31 (least important), the characteristics provided on the posterboards. Participants also rated each characteristic immediately before and after the heterogeneous focus group, on a Likert scale, with #4 (very important), #3 (moderately important), #2 (mildly important) and #1 (not important). This ranking and rating served as a basis for the quantitative comparisons in the results.

A major goal of the focus group interactions was to develop a table of specifications of the student characteristics life science faculty assumed was important for success in introductory college biology. The stakeholders were asked to develop a series of required student characteristics to be placed by the researcher in the form of a table of specifications. Through the table of

specifications, "the focus group covers ...topics on an issue...that might otherwise be left out of a survey" (Edmunds, 1999, p. 4).

In this study, the table of specifications was a list of characteritics that consisted of each of the student characterictics agreed upon by both the secondary and post-secondary groups to be important knowledge, abilities, and dispositions for students entering introductory college biology. It included the original characteristic plus the specifications enumerated as the parts comprising each characterictic.

(5 min.) Closing Comments

- Final Suggestions/Comments

Conclusions: were based primarily on the majority of responses, but unexpected comments/dissentions allowed for further analyses.